Abstract of the Disclosure

This disclosure relates to a smoking product and method of making the same. More particularly, the disclosure relates to a cigarette or similar smoking article which is capable of providing undiluted smoke during the early stages of smoking and which provides smoke diluted by air during the later stages of smoking. The disclosure encompasses smoking products having ventilation holes which are covered or filled with a substance which is disintegrated by the action of the smoke constituents, and particularly the moisture, in the tobacco smoke which result from the burning of the tobacco in said tobacco product. The ventilation holes may be in the wrapper of the smoking product or in the walls of a filter associated with said smoking product or may be in both the wrapper and filter of a smoking product, the holes being spaced some distance away from the end of the smoking product are closed with a water-soluble material during the initial stages of smoking but are opened during subsequent stages of smoking due to the action of the moisture in the tobacco smoke on the material which initially blocks said holes. A particularly preferred water-soluble material for use in accordance with this invention is polyethylene oxide.

A particularly preferred embodiment of the present disclosure is the use of a water-soluble material having a cellular bubble structure. Such materials provide for superior degradation properties when contacted with tobacco smoke constituents and can, if desired, be made of substantially the same color as the wrapper or filter in which the holes are located so that it is virtually unnoticeable before the smoking product is smoked. When the holes are opened by degradation of the film during smoking, they assume a darker appearance which is readily noticeable to the smoker. Thus, the

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smoker can have visible evidence of the opening of the dilution holes with the benefit of the full satisfaction from the smoke during the early stages of smoking and the psychological advantages of seeing the dilution holes open during the later stages of smoking.

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This disclosure relates to a smoking product and method of making the same. It has been known that the amount of smoke delivered to the smoker of a cigarette can be lowered, without increasing the resistance-to-draw of the cigarette, by increasing the proportion of air which is drawn in with the smoke behind the burning coal. It is also known that additional air can be provided with the smoke by using a very porous paper as the wrapper for the tobacco or by placing perforations in the paper. In this way a greater proportion of the combustion products are dissipated to the atmosphere in the intervals between puffing. Cigarettes have also been made wherein ventilation holes have been included in the paper or in the overtipping surrounding the filter plug of a filter cigarette. In addition, various methods have been described for the smoker to select the degree of ventilation before smoking.

None of the above-described methods has been completely satisfactory, however. Cigarettes which have been ventilated to any significant degree have been characterized by many smokers as being "thin", "tasteless", or "not satisfying".

An invention which involves reducing the amount of smoke delivered by a cigarette to the smoker is set forth in United States Patent 2,992,647 to Frank H. J. Figge. The Figge patent involves a method of making a combustible cigarette or the like having built-in means for regulating the combustion temperature, said means comprising perforations or pores in the cigarette paper which are filled with a material that melts or sublimes at such a temperature that the perforations or openings will open up a short distance in advance of the burning area to regulate the amount of air or the percentage of the puff coming through the burning area. While the Figge patent provides advantages over the previously known

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ventilation means, it does not provide a complete solution to the basic problem which includes a combination of (1) reducing the amount of smoke delivered to the smoker of a cigarette, and (2) satisfying the smoker of the cigarette.

The Figge invention, however, while providing an automatic method for opening vent holes in cigarettes, involves an opening of the vent holes upon the approach of the hot coal to the vent holes.

The present invention provides an improvement over Figge in that the holes are more readily opened and at a farther distance from the coal in the present invention than can be achieved by Figge. While I do not wish to be bound by any theory, it is my belief that this is due to the fact that the water-soluble materials used in the present invention are more easily broken down due to moisture in the tobacco smoke than the materials of Figge which are broken down due to the heat of the tobacco coals.

The present invention thus overcomes the disadvantages of the prior art dilution methods and makes possible a smoking product which provides the desired degree of smoking satisfaction while providing lower delivery of tars and nicotine to the smoker on a per puff basis as well as on an overall cigarette basis.

One embodiment of the present invention, the use of a bubble form of water-soluble material, also provides more efficient dilution and provides visible evidence of the opening of the dilution holes, with the benefit of the full satisfaction from the smoke during the early stages of smoking and the psychological advantages of seeing the dilution holes open during the later stages of smoking.

This invention relates to a smoking product and method of making the same. More particularly, the invention relates to a cigarette or similar smoking article which is capable of providing

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undiluted smoke during the early stages of smoking and which provides smoke diluted by air during the later stages of smoking. The invention encompasses smoking products having ventilation holes, formed mechanically or otherwise or present in the paper or wrapper due to the inherent porosity of the same, which are covered or filled with a substance which is disintegrated by the action of the ingredients, particularly the moisture, in the tobacco smoke which results from the burning of the tobacco in said tobacco product. The ventilation holes may be in the wrapper of the smoking product or in the walls of a filter associated with said smoking product or may be in both the wrapper and filter of a smoking product, the holes being spaced some distance away from the end of the smoking product are closed with a water-soluble material during the initial stages of smoking but are opened during subsequent stages of smoking due to the action of the moisture in the tobacco smoke on the material which initially blocks said holes. A particularly preferred water-soluble material for use in accordance with this invention is polyethylene oxide.

A particularly preferred embodiment of the present invention is the use of a water-soluble material having a cellular or bubble structure. Such materials provide for superior degradation properties when contacted with water and can, if desired, be made of substantially the same color as the wrapper or filter in which the holes are located so that it is virtually unnoticeable before the smoking product is smoked. When the holes are opened by degradation of the film during smoking they assume a darker appearance which is readily noticeable to the smoker. Thus, the smoker can have visible evidence of the opening of the dilution holes, with the benefit of the full satisfaction from the smoke during the early stages of smoking and the psychological advantages

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of seeing the dilution holes open during the later stages of smoking.

It is an object of this invention to provide a cigarette which will give substantially undiluted smoke during the early puffs and diluted smoke during the later puffs. It is a further object to provide a cigarette which has a lowered total delivery of smoke components to the smoker. It is a further object to provide a cigarette which the smoker will find to have a reasonable resistance-to-draw and to give a satisfying smoke. It is a still further object of the present invention to provide a cigarette which provides visible evidence of the opening of the dilution holes with the benefit of the full satisfaction from the smoke during the early stages of smoking and the psychological advantages of seeing the dilution holes open during the later stages of smoking.

The above and other objects and advantages of the invention will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

Figure 1 is a perspective view of one embodiment of the present invention, a plain cigarette having openings or vent holes in the wrapper which are covered or filled with a water-soluble cellular plastic film.

Figure 2 is an enlarged fragmentary view of a small area of the covered vent holes in the wrapper of the cigarette in Figure 1.

Figure 3 is a cross-section through one of the covered vent holes in the wrapper of the cigarette shown in Figures 1 and 2, showing the appearance of the coating before the cigarette is smoked.

Figure 4 is a cross-sectional view of the same vent hole shown in Figure 3, after the moisture of the cigarette smoke has

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caused the water-soluble cellular plastic film to break down and the hole to be opened.

Figure 5 is a perspective view of another embodiment of the present invention, a cigarette having openings or vent holes in the filter and in the wrapper, said openings being covered or filled with a water-soluble plastic film.

Referring to Figures 2 and 3, an enlarged portion of cigarette 1 is shown, as indicated in the drawings, which is representative of all openings 4, wherein vent holes 4 are covered by water-soluble cellular plastic film 5 having air bubbles 7. Film 5 blocks passage 6 in vent hole 4.

Referring to Figure 4, opening 4 in paper cylinder 3 is shown with film 5a resulting from the degradation of water-soluble cellular plastic film 4, to form free passage 6 through vent hole 4, which passage connects tobacco 2 with the exterior of the cigarette 1.

Referring now, in detail, to Figure 5, a filter cigarette 10 consists of a cylinder of tobacco 12, encased in a combustible paper cylinder 13, and a filter unit 16 consisting of cellulose acetate filter material 17 and mouthpiece 18. Through paper cylinder 13 and mouthpiece 18 have been punched vent holes 14, which have been covered by water-soluble film 15. When film 15 is degraded by the action of the moisture in the tobacco smoke, vent holes 14 are opened to provide connection between the tobacco 12 and the outside of the cigarette 1 in the tobacco section of the cigarette and between filter material 17 and the outside of cigarette 1, in the filter unit 16 section of the cigarette.

The objects of the present invention may be realized by providing the paper wrapper or the like of a cigarette or other smoking product with holes of sufficient size to provide

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significant dilution of the smoke by air, and covering or plugging these holes with a film which is susceptible to the action of moisture to such a degree that the moisture-laden smoke from the first portion of the cigarette causes the film gradually to dissolve or disintegrate in such a way that the holes are opened after the first few puffs of the cigarette or the like have been taken.

In accordance with this invention, the smoking product delivers undiluted smoke during the initial puff or during the first few puffs, but during the later stages of smoking the smoking product is ventilated, i.e. the smoke is diluted, to any desired degree, as determined by the number and size of the holes, and the nature and thickness of the film covering the holes. The portion of a cigarette rod which should be without such holes will be dependent on the specific rate of action of smoke moisture upon the blocking film and in some instances upon the film thickness. The film and its thickness can be varied to control the proportion of unventilated smoke delivered. Preferably this will be the smoke from the first four to six puffs.

The moisture-susceptible or water-soluble film may consist of a dextrin, starch, or starch derivative, a natural water-soluble gum, or a water-soluble synthetic polymer which is attacked by high humidity. Natural gums useful as film formers include guar gum, gum arabic, tragacanth and pectins. Synthetic resins or polymers useful in the present invention are exemplified by solid polyethylene glycols, polyvinyl alcohols, polyethylene oxides, polyacrylic acids and their salts, and polymers of polyvinylpyrrolidone. Various blends of these materials, used in various molecular weights, may also be used.

Preferred materials are the water-soluble polyalkylene oxides and polyvinyl alcohols.

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The polyalkylene oxide may have a molecular weight between about 70,000 and 5,000,000 and greater can be employed in the invention. The preferred molecular weight of the polyethylene oxide is from about 100,000 to about 300,000.

The polyalkylene oxide film or coating may be prepared using polyethylene oxide or a copolymer of ethylene oxide with less than 50% by weight of propylene oxide, i.e., oxides containing both $-C_2H_4O-$ and $-C_3H_6O-$ groups, and may be also mono- or di- esters of such polyalkylene oxides, for example, the methoxy esters of polyethylene oxides. As used herein, the term "polyalkylene oxide" is intended to include all such materials, including the esters, having molecular weight of from about 70,000 to about 5,000,000.

Illustrative of such materials are polyethylene oxides which have the general formula:

$$HO\ (-C_2H_4-O-)_x\ H$$

wherein x is an integer having a value of from about 1,600 to about 115,000. Such materials may be prepared, generally, by polymerizing alkaline oxides by conventional methods. For example, ethylene oxide can be reacted in accordance with the following equations to yield the polymer:

(1) $$HC\underset{\diagdown\ \diagup}{O}CH + H_2O \longrightarrow HO-CH_2-CH_2-OH$$

(2) $$HO-CH_2-CH_2-OH + {}_n\ (CH\underset{\diagdown\ \diagup}{O}CH) \longrightarrow HO\ (-CH_2-CH_2-O-)_{n+1}\ H$$

Particularly preferred polyalkylene oxides are water-soluble solid polyethylene oxide and copolymers containing at least 50 weight percent of ethylene oxide in copolymerized form with up to 50 weight percent of a second lower olefin oxide, for example, propylene oxide, butylene oxide, and the like.

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In a most preferred embodiment of the present invention, polyethylene oxide and/or the above defined copolymers should have a reduced viscosity value in the range of from about 1.0 to about 75 or even higher, and most preferably should have a reduced viscosity of from about 2 to about 60. Reduced viscosity is an indirect measurement of the molecular weight of the polymer and it is a value obtained by dividing the specific viscosity by the concentration of the alkylene oxide polymer in the solution, the concentration being measured in grams of polymer per 100 milliliters of solvent at a given temperature. The specific viscosity is obtained by dividing the difference between the viscosity of the solution and the viscosity of the solvent by the viscosity of the solvent. The reduced viscosities herein referred to are measured at a concentration of 0.2 gram of polyalkylene oxide in 100 milliliters of acetonitrile at 30°C.

Solid alkylene oxide polymers can be prepared by polymerizing an alkylene oxide in the presence of certain metal carbonate catalysts, such as calcium carbonate, barium carbonate, strontium carbonate and the like. These metal carbonate catalysts can be employed in concentrations in the range from about 0.3 to 3 parts by weight per 100 parts by weight of alkylene oxide. The polymerization reaction can be conducted in the liquid phase at a temperature in the range from about 70°C. to about 150°C. It is preferred that the metal carbonate catalyst contain not more than one part by weight of non-sorbed water per 100 parts by weight of monomer, and at least 0.01 part by weight of sorbed water per 100 parts by weight of catalyst. It is also preferred that the carbonate catalyst be free from ions which reduce their catalytic activity such as, for example, chlorate and thiosulfate ions. Additional details regarding the production of polyalkylene oxide

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can be found in the disclosure in United States Patent No. 3,032,445 and the disclosure in the United States applications which are referred to therein.

A plasticizer such as glycerol or diethylene glycol may be incorporated in the film former to alter its flexibility; a material not a plasticizer which is hygroscopic, such as calcium chloride, may be incorporated to expedite the action of smoke moisture. In addition, materials which react with water or with smoke constituents may be present in the film or bubble coating to cause its deterioration. For example, citric acid and sodium bicarbonate may be present to react with the smoke constituents to cause a rapid breakdown of the water-soluble film.

A filler may be added to the film as a source of heterogeneity or of stress concentration to expedite the disintegrating action of moisture. Some fillers useful in this way include "Alundum", fused alumina, titania, clay, talc, calcium carbonate, silica, aluminum carbide and barium ferrite.

The film-forming solution or dispersion may be applied by roll- or knife-coating or printing for more viscous compositions, by spray or brush for less viscous compositions. Casting, hot melt coating, and other procedures known in the art may be useful in certain instances. Precasting and drying of the film followed by application to the perforated paper or other wrapping web may be employed.

Other embodiments of this invention are possible. The temporary blocking film may contain an agreeable flavoring agent which is gradually released to the smoke by the action of moisture or particulates. The perforated paper may be treated with a release agent or water repellent before the film is applied.

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The coated holes may be located in the innerwrap of a filter with the adjacent overtip having open perforations. Conversely, the overtip perforations may be coatedand those of the innerwrap open. Inherently porous paper may also be employed.

A particular combination which provides outstanding results in accordance with the present invention, involves the use, in a cigarette or the like, of spaced perforations no closer to the smoking end of the cigarette than 20 mm. and having a total surface corresponding to from about 0.2 to about 1.5 percent of the total surface area of the cigarette wrap, said perforations being filled with or coated with a film having a thickness of from 3 to 60 microns and preferably 5 to 15 microns of a polyvinyl alcohol or a polyethylene oxide.

The advantage of employing a film of the type set forth above over a film or coating which is heat degradable, resides in the more accurate control, over the opening of the filled perforations or holes and in the fact that holes can be caused to open a much greater distance from the coal in the cigarette, whereby ventilation can be started and maintained at a desired level with greater accuracy and greater variability and whereby lower total particulate matter is produced.

Particularly preferred films or coatings for use in accordance with the present invention are water-soluble cellular materials or bubble coatings.

Moisture-susceptible, i.e. water-soluble, bubble coatings which may be employed in this embodiment include three-dimensional cellular structures having a multiplicity of microscopic or sub-microscopic voids distributed throughout their volume beneath the outer surface thereof. The material, apart from these voids, is

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substantially continuous and homogeneous and the film as a whole is opaque because of its heterogeneous physical structure due to such voids. When the water-soluble material is contacted with the moisture from tobacco smoke passing past it, it softens and coalesces with attendant collapse of such voids and the opening of the holes filled or covered by such a film or coating.

Under certain circumstances, the coating can be white and can be applied to vent holes in a cigarette whereby the coated holes are virtually invisible. When the cigarette is smoked, the coating is broken down by the moisture in the smoke and the holes open up, turning dark and visible due to the tobacco which is thereby exposed to view.

Such a film may be prepared and applied to the paper base by applying thereto an emulsion of the oil-in-water type, wherein a film-forming plastic is the continuous phase and the dispersed phase is present in the form of multitudinous droplets, at least almost all of which are of microscopic or submicroscopic dimensions, and by drying the film in such manner that the dispersed phase is evaporated without essential disruption or substantial collapse of the cellular structure of the continuous phase. While the gelation of the plastic film and the evaporation of the water therefrom may to a certain extent be simultaneous, in general they occur in substantial sequence in that order in that the plastic layer first attains such a degree of semi-solidity as to be effective to drop the dispersed water droplets. The solvent is then evaporated by diffusion through the rigid, or substantially rigid, cellular walls of the plastic and is replaced by air forming the voids already referred to.

A variation of the oil-in-water system may also be employed,

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however, and has shown certain advantages. In this variation, two non-aqueous liquids, less polar than water, are employed; the two may be miscible, but one is not a solvent for the film-forming resin. When the resin is dissolved in the solvent liquid and the second liquid added, a clear solution may result. The dispersed droplets do not appear until the film has been cast and enough of the solvent liquid has evaporated to force the separation and coalescence of the non-solvent within the film. The trapped droplets then produce bubbles by the same exchange with air that has been described. The advantage of this system lies in the fact that it does not wet the paper and better control of the application is possible. Bubble coatings may contain pigment but this is usually unnecessary for the purposes of the present invention and would merely obscure the desired change in appearance. The coating may be applied by conventional methods to the perforated wrapper or mouthpiece material: for example, it may be printed, roll-coated, knife or brush coated, or sprayed. I have found that a form of coating that coats only the perforations is probably most desirable. Coating preferably is done on the perforated wrapper or the like before the rod is formed, but it could instead take place on the wrapper, tobacco rod or filter rod or the finished cigarette.

The following examples are illustrative:

Example 1

A water dispersion was prepared by placing 70 g. of water in a glass blender jar and slowly adding the following ingredients with agitation at high speed: 3 g. dextrin (canary No. 726 - Clinton Corn Processing Co.), 6 g. starch (No. C3-267 - A.E. Staley Manufacturing Co.), and 9 g. polyvinyl alcohol ("Elvanol" 46-22 - E. I. du Pont de Nemours & Co., Inc.). The resulting yellow,

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heterogeneous mixture was heated 15 minutes at 180°F. with stirring to produce a creamy homogeneous mixture. To this were added 9 g. glycerine (Fisher Scientific Co.) and 152 g. water, and the mixture was stirred and heated again in a water bath at 180°F. for 5 minutes. A filler or abrasive, 60 g. of "Alundum" fused alumina No.320, - 320 mesh (Norton Co.), was stirred into the blend; this additive will settle on standing so that thorough stirring was necessary before application. A very thin coating was applied to perforated cigarette filter tipping paper by means of a camel's hair brush and the paper was dried in air and then in an oven. The perforated paper had 6 lines of holes running circumferentially, or a total of approximately 180 holes per tip, each about 0.025 sq. mm.

Cigarettes were assembled as follows: commercial 20 mm. cellulose acetate tow filters were cut transversely across, 13 mm. from the smoker's end. The tipping paper prepared as described was used with conventional tipping adhesive on the filter exterior to attach the 13 mm. filter portion at a point 6 mm. back of its original position so that a 6 mm. empty space between filter sections remained covered only by the new tipping, with the film-covered vent holes located at this space, and to attach the filters to 65 mm. cigarette rods.

These cigarettes were smoked by machine with a modified cigarette holder which permits measurement of air flow through the walls of the filter end of the cigarette, and this by comparison with the known rate of total flow during puffing will indicate the proportional smoke dilution, usually stated as percent of total flow. The means for determining dilution is a glass sleeve which fits loosely over the filter end of the cigarette and which has a

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side arm leading to a flow meter which is open to the air. The sleeve is covered at each end with thin rubber dam which has a hole through which to slip the cigarette to provide an air-tight fit. The end of the filter tip extending out from this sleeve is placed in the customary manner in the inlet side of a Cambridge filter holder with filter, which in turn is connected with a smoking machine. This machine is controlled in a known fashion to draw a 35 cc. puff during two seconds once every minute. The cigarette is lighted during such a puff, and the resistance-to-draw (pressure drop through the cigarette) and air flow during puffing through the filter wrapping is recorded before lighting, during the first (lighting) puff, and during the smoking until an arbitrary butt length of 35 mm. is reached. At that point the cigarette is removed from its holder, puffing is stopped, and the filter and holder are weighed to determine, by comparison with their initial weight, the amount of total particulate matter (TPM) delivered.

In Table I are shown the comparative results from smoking the experimental cigarettes and the same commercial cigarettes without modification. The opening of the holes is demonstrated by the drop in draw resistance as well as by the dilution.

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Table I

Puff-by-Puff Measurement of Delayed Dilution Cigarettes

	Control		Sample 1		Sample 2	
	RTD*	%Dilution	RTD*	%Dilution	RTD*	%Dilution
Before Smoking	4.4	0	3.2	8	3.0	3
Puff 1	4.5	0	3.3	9	4.0	5
2	5.2	0	4.6	12	4.8	6
3	4.8	0	4.8	12	4.8	6
4	5.0	0	4.4	11	4.8	5
5	4.5	0	4.2	11	4.6	5
6	4.9	0	4.6	11	4.4	6
7	5.0	0	5.2	12	4.2	14
8	4.8	0	5.3	11	4.4	25
9	4.4	0	4.8	23	4.2	50
10	4.4	0	4.8	36	3.6	45
11	4.4	0	4.0	50		

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Example 2

Barrier film in aqueous dispersion was prepared as in the preceding example and applied to perforated tipping paper and dried in the manner described. Cellulose acetate filter plugs 20 mm. long prepared from 4 denier/49,000 total denier tow, with innerwrap removed, were attached by means of this tipping paper to 65 mm. tobacco rods from commercial cigarettes. A cigarette was smoked and changed from 8 percent dilution before smoking to 26 percent after smoking.

Example 3

A non-filter cigarette 85 mm. in length is perforated with a needle with eight holes at about 2 cm. from one end with the result that dilution, measured unlit, is approximately 90%. These holes are then painted over a suspension of film-former prepared as in Example 1. The cigarette is exposed to room air for more than 24 hours at 60% relative humidity. Unlit dilution is measured as zero. The end furthest from the holes is lighted and machine smoking was carried out as before. Dilution increases after the sixth puff to 19% and on the final puff to 42%.

Example 4

A mixture of 16 g. of polyvinyl alcohol GM-14 (Nippon Gohski, Osaka, Japan) and 400 ml. of water was stirred until all the resin was in solution. Tipping paper having 180 holes totalling 0.0063 sq. in. was coated lightly with this solution and oven-dried. The paper was then used to attach sections of filter tip to a 65 mm. cigarette tobacco rod in the "plug-space-plug" configuration and with the dimensions described in Example 1. The cigarette was smoked and dilution at the beginning and end of smoking was 7 and 20%, respectively.

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Details of dilution holes and tipping paper:

Paper 1.8 mils thick (1 mil = 0.001 inch)

Holes 5 x 7 mils or 35 sq. mils each (1 sq. mil = 10^{-6} sq. inch)

180 holes or total area 6300 sq. mils.

Total Area 0.0063 sq. in.

Area vs. % Dilution for Single Layer of Paper

Open Area Sq. Mils.	% Dilution
35	8
350	25
700	40
1300	60
2100	75
6300	93

Thickness of a representative blocking film, composition of Example 1, is less than that of paper; estimated by microscopy 0.30 - 0.75 mils.

In the examples which follow, the water-soluble coating material was prepared as follows:

One hundred cc. of ethylene dichloride was added to a laboratory blender. The blender was run for a period of two minutes at 1500 revolutions per minute (rpm). The plasticizer, when employed, was added to the ethylene dichloride, while polyethylene oxide was added over a period of one minute and the blender was then run for an additional five-minute period at 1860 rpm. One gram of Varsol No. 3 (a petroleum solvent sold by Esso Standard Oil Co. composed principally of paraffins, napthanes and aromatics) was then added to the mixture in the blender and the blender was run for an additional period of five minutes at 1860 rpm. The resulting material was then applied to standard cigarette paper having perforations as indicated in each example. The coating method, in greater detail, comprises a knife coater

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application of the liquid solution to the cigarette paper with a subsequent air drying step resulting in a cellular coating.

The perforations in each line as indicated in the examples comprised rectangular punctures of 0.005 to 0.007 dimensions spaced at intervals of 0.028" in a line such that in the finished cigarette the punctures appeared in a plane parallel to the longitudinal axis of the cigarette. The spacing of each row of perforations was 8 1/3 mm. from the center line of the cigarette paper. Distance between lines was 0.22". Cigarette rods had a 25 mm. section of unperforated paper in the front half, i.e. at the smoking end.

Example 5

In this example, 20 grams of a water-soluble polyethylene oxide having a molecular weight of 300,000 (Polyox WSRN 750) was employed as the polyethylene oxide. The coating material was prepared by the method set forth above. The coating was applied to a cigarette having six lines of perforations consisting of three rows of two lines each. The average thickness of the coating applied to the perforations was nine microns. The cigarette was tested on a standard smoke testing machine (Philip Morris Automatic Smoking Machine of the type sold by Phipps & Bird, Inc.) and was compared with a control cigarette which was exactly the same except that it had no perforations or coating. The cigarettes were evaluated for total particulate matter on a puff-by-puff basis in accordance with the standard test which is described in Analytical Chemistry, 31, 1705-1709 (1958), Wartman, Cogbill and Harlow. The cigarettes employed had a standard 20 mm. cellulose acetate filter and a rod of tobacco 65 mm. in length. The results obtained are set forth in Table II.

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Table II

Puff No.	Experimental Cigarette	Control Cigarette
1	1.5 mg.	1.5 mg.
2	1.8	1.8
3	1.9	2.2
4	2.0	2.3
5	1.0	2.4
6	2.1	2.7
7	2.2	2.9
8	2.3	3.1
9	2.5	3.3

Example 6

In this example, 20 grams of a water-soluble polyethylene oxide having a molecular weight of 200,000 (Polyox WSRN 80) was employed as the polyethylene oxide. The coating material was prepared by the method set forth in Example 5. The coating was applied to a cigarette having nine lines of perforations consisting of three rows of three lines each. The average thickness of the coating applied to the perforations was ten microns. The cigarette was tested on a standard smoke testing machine (Philip Morris Automatic Smoking Machine of the type sold by Phipps & Bird, Inc.) and was compared with a control cigarette which was exactly the same except that it had no perforations or coating. The cigarettes were evaluated for total particulate matter on a puff-by-puff basis in accordance with the standard test which is described in Analytical Chemistry, 31, 1705-1709 (1958), Wartman, Cogbill and Harlow. The cigarettes employed had a standard 20 mm. cellulose acetate filter and a rod of tobacco 65 mm. in length. The results obtained are set forth in Table III.

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Table III

Puff No.	Experimental Cigarette	Control Cigarette
1	1.3 mg.	1.3 mg.
2	1.5	1.7
3	1.7	1.8
4	1.5	2.0
5	1.5	2.3
6	1.4	2.4
7	1.7	2.4
8	1.6	2.8
9	1.8	2.9
10	2.3	3.3

Example 7

In this example a blend of eight grams of a water-soluble polyethylene oxide having a molecular weight of 200,000 (Polyox WSRN 80) and three grams of a water-soluble polyethylene oxide (WSRN 20) having a molecular weight below 100,000 was employed as the polyethylene oxide. The coating material was prepared by the method set forth in Example 5.

The coating was applied to a cigarette having six lines of perforations consisting of three rows of two lines each. The average thickness of the coating applied to the perforations was fourteen microns. The cigarette was tested on a standard smoke testing machine (Philip Morris Automatic Smoking Machine of the type sold by Phipps & Bird, Inc.), and was compared with a control cigarette which was exactly the same except that it had no perforations or coating. The cigarettes were evaluated for total particulate matter on a puff-by-puff basis in accordance with the standard test which is described in Analytical Chemistry, 31, 1705-1709 (1958), Wartman, Cogbill and Harlow. The cigarettes employed had a standard 20 mm. cellulose acetate filter and a rod of tobacco 65 mm. in length. The results obtained are set forth in Table IV.

Table IV

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Source: https://www.industrydocuments.ucsf.edu/docs/lhnm0000

Puff No.	Experimental Cigarette	Control Cigarette
1	1.5 mg.	1.4 mg.
2	1.7	1.8
3	2.1	2.1
4	2.2	2.1
5	2.2	2.5
6	2.1	2.5
7	2.3	2.6
8	2.5	2.9
9	2.5	3.3

Example 8

In this example, a blend of ten grams of a water-soluble polyethylene oxide having a molecular weight of 200,000 (Polyox WSRN 80) and two grams of a water-soluble polyethylene oxide (WSR 301) having a molecular weight of four million was employed as the polyethylene oxide. The coating material was prepared by the method set forth in Example 5. The coating was applied to a cigarette having nine lines of perforations consisting of three rows of three lines each. The average thickness of the coating applied to the perforations was seven microns. The cigarette was tested on a standard smoke testing machine (Philip Morris Automatic Smoking Machine of the type sold by Phipps & Bird, Inc.), and was compared with a control cigarette which was exactly the same except that it had no perforations or coating. The cigarettes were evaluated for total particulate matter on a puff-by-puff basis in accordance with the standard test which is described in Analytical Chemistry, 31, 1705-1709 (1958), Wartman, Cogbill and Harlow. The cigarettes employed had a standard 20 mm. cellulose acetate filter and a rod of tobacco 65 mm. in length. The results obtained are set forth in Table V.

Table V

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Source: https://www.industrydocuments.ucsf.edu/docs/lhnm0000

Puff No.	Experimental Cigarette	Control Cigarette
1	1.3 mg.	1.4 mg.
2	1.4	1.8
3	2.0	2.1
4	2.0	2.1
5	1.9	2.5
6	2.1	2.5
7	2.3	2.6
8	2.5	2.9
9	2.8	3.3

Example 9

In this example, one gram of a plasticizer (Tergitol NP40 sold by Union Carbide Corporation (an alkyl phenyl ether of polyethylene glycol)) was employed in addition to the other ingredients employed in Example 5. Twenty grams of a water-soluble polyethylene oxide having a molecular weight of 200,000 (WSRN 80) was employed as the polyethylene oxide. The coating material was prepared by the method set forth in Example 5. The coating was applied to a cigarette having six lines of perforations consisting of three rows of two lines each. The average thickness of the coating applied to the perforations was ten microns. The cigarette was tested on a standard smoke testing machine (Philip Morris Automatic Smoking Machine of the type sold by Phipps & Bird, Inc.), and was compared with a control cigarette which was exactly the same except that it had no perforations or coating. The cigarettes were evaluated for total particulate matter on a puff-by-puff basis in accordance with the standard test which is described in Analytical Chemistry, 31, 1705-1709 (1958), Wartman, Cogbill and Harlow. The cigarettes employed had a standard 20 mm. cellulose acetate filter and a rod of tobacco 65 mm. in length. In the test cigarettes involved in this example, the perforations were larger than in the preceding example and were rectangular in shape having the dimensions 0.010 inch in a direction transverse to the axis of

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the cigarette and 0.014 inch in a direction parallel to the axis of the cigarette. A distance of thirty mm. from the smoking end of the cigarette was left without perforations. From this point on toward the smoker's end of the cigarette perforations were present in three rows of two lines each with a distance between the two lines of 0.032 inch and the interval between perforations in the lines was 0.30 inch. The results obtained are set forth in Table VI.

Table VI

Puff No.	Experimental Cigarette	Control Cigarette
1	1.5 mg.	1.4 mg.
2	1.7	1.7
3	1.8	1.8
4	1.9	1.9
5	1.8	2.3
6	1.4	2.4
7	1.6	2.5
8	1.7	2.8
9	1.8	3.0
10	2.0	

As mentioned earlier in this specification, the dimensions and arrangements of the holes or perforations will vary in accordance with the desired results. They may be arranged and may be of the sizes and shapes shown in the above-mentioned Figge patent or they may have other sizes, shapes and configurations.

A particular combination which provides outstanding results in accordance with the present invention involves the use, in a cigarette or the like, of spaced perforations no closer to the smoking end of the cigarette or smoking article than 20 mm., said perforations having a total surface corresponding to from about 0.2 to about 1.5% of the total surface area of the cigarette wrap, said perforations being filled with or coated with a film having an average thickness across the holes or perforations of

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from about 3 to 60 microns and preferably of about 5 to 15 microns of a water-soluble material, most preferably polyethylene oxide.

The advantage of employing a water-soluble film over a film or coating which is not water-soluble, resides in the more accurate control over the opening of the filled perforations or holes and in the fact that the holes can be caused to open a much greater distance from the coal in the cigarette whereby ventilation can be started and maintained at a desired level with greater accuracy and greater control.

I have found that the use of a water-soluble bubble coating for closing the perforations or holes provides even greater improvements. Such a water-soluble bubble coating can be caused to open or disintegrate at an even greater distance from the coal than a water-soluble film which is not a bubble coating. Furthermore, the use of a bubble coating to form the film which seals the holes may be characterized by a white opacity which disappears as the film dissolves or in the moments before when collapse of the bubble structure brings transparency. The smoker can see the vent holes being opened. The bubble structure also results in a thicker film from a given weight of material, and this added thickness permits easier control during application. The greater bulk or thickness means that a difference of a fraction of a mil is of less consequence than it would be otherwise. The bubble-coating technique and the resulting film have been described earlier. The film which results contains many small air bubbles which may occupy much more space than the solid portion but, in general, the bubbles are not connected. They have roughly the size of the wavelength of visible light and the light-scattering effect of the bubbles gives the film opacity and brightness. The bubbles are introduced by

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Source: https://www.industrydocuments.ucsf.edu/docs/lhnm0000

evaporation of a liquid which is first dispersed as minute droplets in the continuous phase with which the liquid is immiscible. The continuous phase or binder, which is a solution of the film-former in a different liquid, gels after coating is applied, usually due to partial evaporation of the latter liquid. The gel then fixes the liquid-filled bubbles. There is some shrinkage of the structure during the drying while the liquid is passing out of the bubbles and diffusing to the surroundings and air is replacing it in the bubbles.

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Source: https://www.industrydocuments.ucsf.edu/docs/lhnm0000

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A cigarette wrapper or the like comprising a combustible material having spaced apertures therein, and non-toxic filling material normally closing said apertures, which filling material comprises a water-soluble material.

2. A cigarette or the like, including a combustible wrapper having perforations filled with a non-toxic water-soluble filling material.

3. The cigarette wrapper of claim 1, wherein said filling material is a three-dimensional cellular structure, including a multiplicity of discrete microscopic or sub-microscopic enclosed voids beneath the outer surface thereof and distributed throughout the volume of the structure.

4. The cigarette of claim 2, wherein said filling material is a three-dimensional cellular structure, including a multiplicity of discrete microscopic or submicroscopic enclosed voids beneath the outer surface thereof and distributed throughout the volume of the structure.

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Source: https://www.industrydocuments.ucsf.edu/docs/lhnm0000

582-534 Canada

Canada
Assignment
Pending Application
Sole Inventor

In consideration of One ($1.00) dollar, and other good and valuable consideration paid to me by PHILIP MORRIS INCORPORATED, a corporation organized under the laws of the State of Virginia, United States of America, with offices at Richmond, Virginia, United States of America and at 100 Park Avenue, New York, New York 10017, United States of America, hereinafter called the Assignee, the receipt whereof is hereby acknowledged, I do hereby sell and assign unto the said Assignee, all my right, title and interest in Canada in and to my invention relating to

SMOKING PRODUCT AND METHOD OF MAKING THE SAME

as fully described and claimed in the application for a patent for such invention and to all my corresponding right, title and interest in and to any patent which may issue therefor.

Signed at Richmond, Virginia, U.S.A.
this 25th day of March, 1969.

Ronald A. Tamol
RONALD A. TAMOL

CERTIFICATE

UNITED STATES OF AMERICA)
STATE OF VIRGINIA) ss:
CITY OF RICHMOND)

On this 25th day of March, 1969, personally appeared before me, the above-named RONALD A. TAMOL, who acknowledged that he signed the above document as his voluntary act for the purposes therein set forth.

Registered May 9, 1969
Reg. No. 748595

M. Esler Anskeep
Notary Public, ~~Commissioner for Oaths; Justice of the Peace or Like Official~~.

(seal)

My Commission Expires August 22, 1970

7.

Cowling, MacTavish, Osborne & Henderson
Ottawa Canada

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582-534 Canada

Canada
Assignment
Pending Application
Sole Inventor

In consideration of One ($1.00) dollar, and other good and valuable consideration paid to me by PHILIP MORRIS INCORPORATED, a corporation organized under the laws of the State of Virginia, United States of America, with offices at Richmond, Virginia, United States of America and at 100 Park Avenue, New York, New York 10017, United States of America, hereinafter called the Assignee, the receipt whereof is hereby acknowledged, I do hereby sell and assign unto the said Assignee, all my right, title and interest in Canada in and to my invention relating to

SMOKING PRODUCT AND METHOD OF MAKING THE SAME

as fully described and claimed in the application for a patent for such invention and to all my corresponding right, title and interest in and to any patent which may issue therefor.

Signed at Richmond, Virginia, U.S.A.
this 25th day of March, 1969.

Ronald A. Tamol
RONALD A. TAMOL

CERTIFICATE

UNITED STATES OF AMERICA)
STATE OF VIRGINIA) ss:
CITY OF RICHMOND)

On this 25th day of March, 1969, personally appeared before me, the above-named RONALD A. TAMOL, who acknowledged that he signed the above document as his voluntary act for the purposes therein set forth.

J. Eades Snakenberg
Notary Public, ~~Commissioner for Oaths, Justice of the Peace or Like Official.~~

(seal)

My Commission Expires February 12, 1970

7. Gowling, MacTavish, Osborne & Henderson
Ottawa Canada

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582-534

Canada
Application by Assignee
Convention

The Petition of PHILIP MORRIS INCORPORATED, a corporation organized under the laws of the State of Virginia, United States of America, of 100 Park Avenue, New York, New York 10017, United States of America, sheweth:

1. That RONALD A. TAMOL
whose full post office address is 5119 Caledonia Road, Richmond, Virginia, United States of America,

made the invention entitled SMOKING PRODUCT AND METHOD OF MAKING THE SAME

which is described and claimed in the specification submitted herewith.

2. That the entire right to obtain a patent for the said invention has been assigned to your Petitioner.

3. That your Petitioner verily believes that it is entitled to a patent for the said invention having regard to the provisions of The Patent Act.

4. That your Petitioner requests that this application be treated as entitled to the rights accorded by Section 29 of the said Act having regard to the application of which particulars are set out below, and represents that the said application is the first application for patent for the said invention filed in any country by it or anyone claiming under it.

United States of America, Serial No. 728,140, filed May 10, 1968

5. That your Petitioner hereby nominates Gowling, MacTavish, Osborne & Henderson, 116 Albert Street, Ottawa, Canada, to be its representatives for all purposes of the said Act, including the service of any proceedings taken thereunder.

6. That your Petitioner hereby appoints the said Gowling, MacTavish, Osborne & Henderson, as its agents, with full power of revocation and substitution, to sign the petition and drawings, to amend the specification and drawings, to prosecute the application, and to receive the patent granted on the said application; and ratifies any act done by the said appointees in respect of the said application.

7. That your Petitioner therefore prays that a patent may be granted to it for the said invention.

SIGNED at Richmond, Virginia, New York, U.S.A.
this 25th day of March, 1969.

PHILIP MORRIS INCORPORATED

By: Helmut P. Wabcham
Vice President

5. Gowling, MacTavish, Osborne & Henderson
Ottawa Canada

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FIG. 1

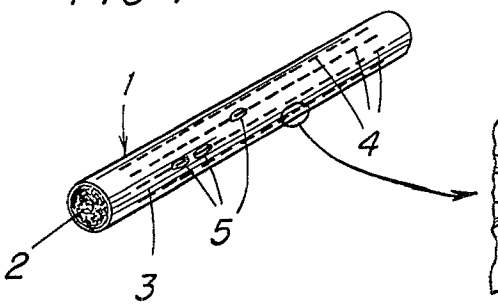


FIG. 2

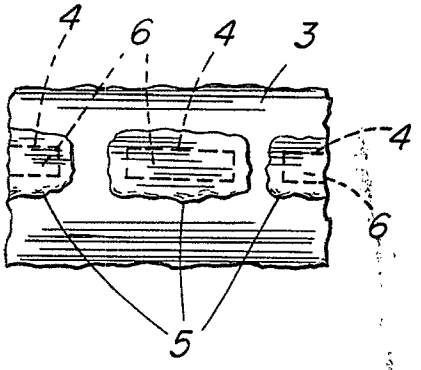


FIG. 3

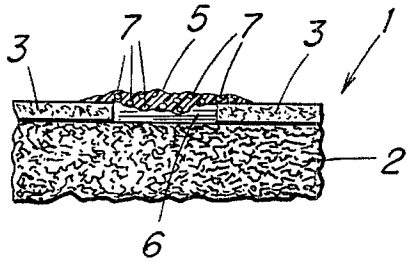


FIG. 4

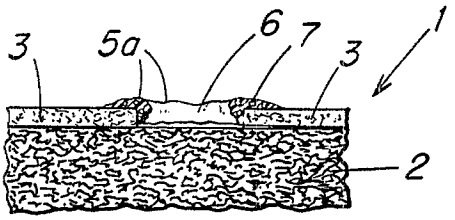
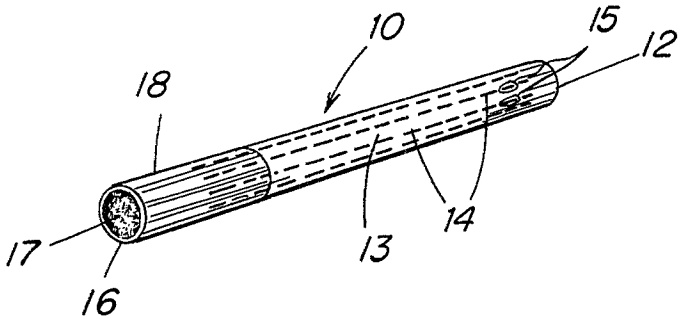


FIG. 5



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